

PolySwitch Resettable Devices

Telecommunications & Networking Devices

This family of telecommunication and networking devices was initially designed to meet the growing demand for resettable overcurrent protection. These product families help provide protection against damage caused by power cross and power induction surges as defined in ITU, Telcordia GR1089, and UL60950. Available in chip, surface-mount, and radial-leaded configurations, TE's PolySwitch devices help improve the reliability of customer premise and network equipment world wide.



Benefits

- Many product choices give engineers more design flexibility
- Compatible with high volume electronics assembly
- Assist in meeting regulatory equipment requirements
- Improved line balance
- Applicable for legacy POTS and modern digital communications equipment

Features

- RoHS compliant
- Resettable overcurrent protection
- Surface-mount, radial-leaded, and chip form factors
- Fast time-to-trip
- Agency recognition: UL, CSA, TÜV
- Resistance sorted and matched devices available
- Low parasitic capacitance/flat impedance with frequency

Applications

- | | | |
|----------------------|---------------------------------|---|
| • Modems | • PBX systems | • Powered ethernet systems |
| • Phone sets | • MDF modules | • VoIP (Voice over Internet Protocol) equipment |
| • Fax machines | • Analog and digital line cards | • LAN, WAN equipment |
| • Phone wall outlets | • T1/E1 equipment | • Customer premise equipment |
| • Alarm systems | • xDSL modems and splitters | • Access network hardware |

Application Guide for Telecommunications and Networking Devices*

To use this guide, follow the steps below:

1. Select your equipment type from the guide below.
2. Select the type of protection depending on the agency and regional specifications in the second column.
3. Select the form factor for your application.
4. Use the Agency Specification/ PolySwitch Device Selection Guide on the next page to select a specific part number for each application based on the agency requirements.
5. Parts with fast time-to-trip or low resistance are available. Please consult a TE Circuit Protection representative.

| Application | Region/ Specification | Overcurrent Protection | | |
|--|---------------------------------|---------------------------------|---------------|-------------|
| | | Form Factor | | |
| | | Radial-leaded | Surface-mount | Chip |
| Customer Premises equipment | North America | TRF600-150 | TS600-170F | |
| IT equipment Analog modems, V.90 modems, ISDN modems, xDSL modems, ADSL splitters, phone sets, fax machines, answering machines, caller ID, internet appliances, PBX systems, POS terminals, wall plugs | TIA-968-A, | TR600-150F-EX | TS600-200F | |
| | UL 60950, | TRF600-160 | TSM600-250F | |
| | GR1089 Port Type 3 [‡] | TRF600-400 | TSM600-400F | |
| | Europe/Asia/ | TRF250-120 | TS250-130F | |
| | South America | TRF250-120T | TSV250-130F | |
| | ITU K.21 | TRF250-145 | | |
| | | TRF250-183 | | |
| | | TRF250-184 | | |
| Access network equipment (†) Remote terminals, line repeaters, multiplexers, cross-connects, WAN equipment | North America | TRF600-160 | TS600-170F | |
| | GR1089 Port Type 5 [‡] | TRF600-400 | TS600-200F | |
| | | | TS600-400F | |
| | | | TSM600-250F | |
| | | | TSM600-400F | |
| | | | FT600-1250** | |
| | Europe/Asia/ | TRF250-120 | TS250-130F | |
| | South America | TRF250-120T | TSV250-130F | |
| | ITU K.45 | TRF250-145 | | |
| | | TRF250-183 | | |
| TRF250-184 | | | | |
| Central office switching equipment (†) Analog/POTS linecards, ISDN linecards, xDSL modems, ADSL/VDSL splitters, T1/E1 linecards, multiplexers, CSU/DSU, servers | North America | TRF600-160 | TS600-170F | |
| | GR1089 Port Type 1 [‡] | TRF600-400 | TS600-200F | |
| | | | TS600-400F | |
| | | | TSM600-250F | |
| | | | TSM600-400F | |
| | | | FT600-1250** | |
| | Europe/Asia/ | TRF250-120 | TS250-130F | TCF250-180 |
| | South America | TRF250-120T | TSV250-130F | |
| | ITU K.20 | TRF250-145 | | |
| | | TRF250-183 | | |
| TRF250-184 | | | | |
| | | | | |
| Primary protection modules (†) MDF modules, Network Interface Devices (NID) | North America | TRF250-183 | | |
| | Telcordia GR-974 | TRF250-184 | | |
| | | | | |
| | Europe/Asia/ | TRF250-055UT | TSL250-080F | TCF250-100T |
| | South America | TRF250-080U | TS250-130F | TCF250-120T |
| | ITU K.20 | TRF250-110U | TSV250-130F | TCF250-145T |
| | | TRF250-120 | | TCF250-180 |
| | | TRF250-120T | | |
| | | TRF250-145 | | |
| | | TRF250-183 | | |
| | TRF250-184 | | | |
| Short-haul/intrabuilding communications equipment (†) LAN equipment, VoIP cards, cable telephony NIUs, wireless local loop handsets | North America | TRF250-080U | TSL250-080F | |
| | GR1089 Port Type 2 [‡] | TRF250-120 | TS250-130F | |
| | | GR1089 Port Type 4 [‡] | TRF250-120T | TSV250-130F |
| | | TRF250-145 | | |
| | | TRF250-183 | | |
| | | TRF250-184 | | |
| | | | | |
| | Europe/Asia/ | TRF250-120 | TS250-130F | |
| | South America | TRF250-120T | TSV250-130F | |
| | ITU K.21 | TRF250-145 | | |
| TRF250-183 | | | | |
| TRF250-184 | | | | |

| Application | Region/ Specification | Overcurrent Protection | | | |
|---|--|------------------------|-----------------------|---------------|---------------------------------|
| | | Form Factor | Radial-leaded | Surface-mount | Chip |
| LAN intrabuilding power cross protection LAN equipment, VoIP cards, IP phones | North America GR1089 Port Type 4 [‡] | | TRF250-080U | TSL250-080F | |
| | | | TRF250-120 | TS250-130F | |
| | | | TRF250-120T | TSV250-130F | |
| | | | TRF250-145 | | |
| | | | TRF250-183 | | |
| | | | TRF250-184 | | |
| IEEE 802.3AF/AT Power over Ethernet protection | | | | | |
| Powered Ethernet switches and terminals, IP phones, wireless LAN base stations, microcellular base stations, VoIP cards | | | | | decaSMDC050F/60-2 ^{††} |
| Cable telephony powering system | | | | | |
| Power passing taps | | | BBRF550 ^{‡‡} | | |

* This list is not exhaustive. TE Circuit Protection welcomes our customers' input for additional application ideas for PolySwitch resettable devices.

† For improved line balance in these applications, resistance-matched parts are recommended.

‡ May require additional impedance or coordination with primary protector.

** FT600-1250 are surface mount telecom fuse devices. FT600-0500 and FT600-2000 reference also available. See telecom fuses section.

†† For details on decaSMDC050F/60-2, see surface-mount devices section.

‡‡ For details on BBRF series, see radial-leaded devices section.

Agency Specification/Selection Guide for Telecommunications and Networking Devices

Use the guide below to select the PolySwitch devices which are typically used in your application. The following pages contain the specifications for the part numbers recommended below. PolySwitch devices assist telecommunication equipment in meeting the applicable protection requirements of these industry specifications. Refer to individual agency specifications for test procedures and circuit schematics. Users should independently evaluate the suitability of, and test each product for their application.

| Family | Product* | Lightning | Power Cross/Contact/Induction |
|--------|-------------|--|---|
| TCF250 | TCF250-100T | ITU K.20 – 1.0kV 10/700µs | PRCYD/T694 |
| | | GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 0.2A ² s ITU K.20/21/45 – 1A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc |
| | TCF250-120T | ITU K.20/21/45 – 1.5kV 10/700µs | ITU K.20/21/45 – 230V _{AC} , 10Ω |
| | TCF250-145T | ITU K.20/21/45 – 4.0kV 10/700µs [†] | ITU K.20/21/45 – 0.2A ² s |
| | TCF250-180 | GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 1A ² s [†] ITU K.20/21/45 – 10A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc |

* Applies to all products which share the same prefix.

† Tested with 230V gas discharge tube primary protector.

| Family | Product* | Lightning | Power Cross/Contact/Induction | |
|---------------------|------------------------|---|---|---|
| TRF250 | TRF250-055UT | ITU K.20 – 1.0kV 10/700µs | ITU K.20 – 230V _{AC} , 10Ω | |
| | TRF250-080U | ITU K.20 – 1.0kV 10/700µs GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20 – 230V _{AC} , 10Ω ITU K.20 – 0.2A ² s ITU K.20 – 1A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc | |
| | TRF250-110U | ITU K.20/21/45 – 1.5kV 10/700µs | ITU K.20/21/45 – 230V _{AC} , 10Ω | |
| | TRF250-120 | ITU K.20/21/45 – 4.0kV 10/700µs [†] | ITU K.20/21/45 – 0.2A ² s | |
| | TRF250-120T | GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 1A ² s [†] | |
| | TRF250-120U | | ITU K.20/21/45 – 10A ² s [†] | |
| | TRF250-120UT | | GR-1089 Port Type 4 – 120V _{AC} , 25Asc | |
| | TRF250-145 | | | |
| | TRF250-145U | | | |
| | TRF250-183 | | | |
| | TRF250-184 | ITU K.20/21/45 – 1.5kV 10/700µs ITU K.20/21/45 – 4.0kV 10/700µs [†] GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 230V _{AC} , 10Ω ** ITU K.20/21/45 – 0.2A ² s ITU K.20/21/45 – 1A ² s [†] ITU K.20/21/45 – 10A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc | |
| | TS250/TSV250 | TSV250-130F | ITU K.20/21/45 – 1.5kV 10/700µs | ITU K.20/21/45 – 230V _{AC} , 10Ω |
| | | TS250-130F | ITU K.20/21/45 – 4.0kV 10/700µs [†] GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 0.2A ² s ITU K.20/21/45 – 1A ² s [†] ITU K.20/21/45 – 10A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc |
| TS250-130F-RB | | ITU K.20/21/45 – 1.5kV 10/700µs ITU K.20/21/45 – 4.0kV 10/700µs [†] GR-1089 Port Types 2 & 4 – 1st Level | ITU K.20/21/45 – 230V _{AC} , 10Ω ITU K.20/21/45 – 0.2A ² s ITU K.20/21/45 – 1A ² s [†] ITU K.20/21/45 – 10A ² s [†] GR-1089 Port Type 4 – 120V _{AC} , 25Asc | |
| | | | | |
| TSL250 | TSL250-080F | GR-1089 Port Types 2 & 4 – 1st Level ITU K.20 – 1.0kV 10/700µs | GR-1089 Port Type 4 – 120V _{AC} , 25Asc ITU K.20/21/45 – 230V _{AC} , 10Ω ITU K.20/21/45 – 0.2A ² s ITU K.20/21/45 – 1A ² s [†] | |
| TRF600 | TRF600-150 | TIA-968-A Types A & B | UL60950 – 600V _{AC} , 40Asc | |
| | TR600-150F-EX | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level ^{††} | UL60950 – 600V _{AC} , 40Asc | |
| | TR600-150F-EX-RA-B-0.5 | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level ^{††} | UL60950 – 600V _{AC} , 40Asc | |
| | TRF600-160 | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level ^{††} | Telcordia GR-1089 – 600V _{AC} , 60Asc | |
| | TRF600-400 | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level | Telcordia GR-1089 – 600V _{AC} , 60Asc | |
| TS600 | TS600-170F | TIA-968-A Types A & B | UL60950 – 600V _{AC} , 40Asc | |
| | TS600-200F-RA | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level ^{††} | Telcordia GR-1089 – 600V _{AC} , 60Asc | |
| | TS600-400F | | | |
| TSM600 | TSM600-250F | TIA-968-A Types A & B | UL60950 – 600V _{AC} , 40Asc | |
| | TSM600-250F-RA | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level ^{††} | Telcordia GR-1089 – 600V _{AC} , 60Asc | |
| | TSM600-400F | TIA-968-A Types A & B GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level | UL60950 – 600V _{AC} , 40Asc Telcordia GR-1089 – 600V _{AC} , 60Asc | |
| FT600 ^{**} | FT600-0500 | TIA-968-A - Types A & B | UL60950 – 600V _{AC} , 40Asc | |
| | FT600-1250 | | | |
| | FT600-2000 | GR-1089 Port Types 1, 3, & 5 – 1st & 2nd Level | Telcordia GR-1089 – 600V _{AC} , 60Asc | |

* Applies to all products which share the same prefix.

† Tested with 230V gas discharge tube primary protector.

‡ Tested with 350V gas discharge tube primary protector.

** See SCD for additional application fault ratings.

†† May require additional series resistor to help telecommunication equipment pass Surge 3 (1kV, 10/1000µs).

‡‡ See telecom fuses section.

Table T1 Product Series: Size, Current Rating, Voltage Rating, Typical Resistance for Telecommunications and Networking Devices

| | TCF250 | TRF250 | TS250 | TSV250 | TSL250 | TS600 TSM600 | TRF600 |
|---|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------------|---------------------------------------|---------------------------------------|
| Voltage Rating (V_{AC})* (Interrupt) | 250 | 250 | 250 | 250 | 250 | 600 | 600 |
| Specification | ITU GR-1089 Ports 2 & 4 | ITU GR-1089 Ports 2 & 4 | ITU GR-1089 Ports 2 & 4 | ITU GR-1089 Ports 2 & 4 | GR-1089 Ports 2 & 4 | UL60950 GR-1089 Ports 1, 3, & 5 | UL60950 GR-1089 Ports 1, 3, & 5 |
| Hold Current (A) | | | | | | | |
| 0.055 | — | 20.0Ω | — | — | — | — | — |
| 0.080 | — | 17.0Ω | — | — | 8.0Ω | — | — |
| 0.100 | 11.0Ω | — | — | — | — | — | — |
| 0.110 | — | 7.0Ω | — | — | — | — | — |
| 0.120 | 10.5Ω | 8.0Ω | — | — | — | — | — |
| 0.130 | — | — | 9.0Ω | 5.5Ω | — | — | — |
| 0.145 | 7.0Ω | 4.5Ω | — | — | — | — | — |
| 0.150 | — | — | — | — | — | — | 8.0Ω |
| 0.160 | — | — | — | — | — | — | 6.0Ω |
| 0.170 | — | — | — | — | — | 11.0Ω | — |
| 0.183 | — | 1.3Ω | — | — | — | — | — |
| 0.184 | — | 1.9Ω | — | — | — | — | — |
| 0.200 | — | — | — | — | — | 8.5Ω | — |
| 0.250 | — | — | — | — | — | 3.5Ω | — |
| 0.400 | — | — | — | — | — | 1.2Ω | 1.2Ω |

Voltage Ratings for Telecommunications and Networking Devices

For circuit protection telecommunications devices there are two applicable voltage ratings. These are **V_{MAX} Operating** and **V_{MAX} Interrupt**. To help understand the nature of these two different voltage ratings, the following definitions are provided:

V_{MAX} Operating : For telecommunications devices this is the voltage used to obtain component recognition under UL1434. Most circuit protection devices are certified at 60V but can withstand higher V_{MAX} Interrupt conditions as noted above. See Table T3 for its V_{MAX} Operating.

***V_{MAX} Interrupt** : Under specified conditions this is the highest voltage that can be applied to the device at the maximum current. Devices have been designed to trip safely under higher power level cross conditions, as listed above, to assist equipment in meeting the appropriate industry conditions.

Table T2 Thermal Derating for Telecommunications and Networking Devices [Hold Current (A) at Ambient Temperature (°C)]

| Part Number | Maximum Ambient Temperature | | | | | | | | |
|---|-----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| | -40°C | -20°C | 0°C | 20°C | 40°C | 50°C | 60°C | 70°C | 85°C |
| Chip* — 250V_{AC} | | | | | | | | | |
| TCF250 | | | | | | | | | |
| TCF250-100T | 0.155 | 0.138 | 0.119 | 0.100 | 0.083 | 0.073 | 0.064 | 0.055 | 0.042 |
| TCF250-120T | 0.186 | 0.165 | 0.143 | 0.120 | 0.099 | 0.088 | 0.077 | 0.066 | 0.050 |
| TCF250-145T | 0.225 | 0.199 | 0.172 | 0.145 | 0.119 | 0.106 | 0.093 | 0.080 | 0.060 |
| TCF250-180† | 0.269 | 0.240 | 0.211 | 0.180 | 0.153 | 0.138 | 0.123 | 0.109 | 0.087 |
| Radial-led* — 250V_{AC} | | | | | | | | | |
| TRF250 | | | | | | | | | |
| NEW TRF250-055UT | 0.085 | 0.076 | 0.065 | 0.055 | 0.045 | 0.041 | 0.035 | 0.030 | 0.023 |
| TRF250-080U | 0.124 | 0.110 | 0.095 | 0.080 | 0.066 | 0.059 | 0.051 | 0.044 | 0.033 |
| TRF250-110U | 0.171 | 0.151 | 0.131 | 0.110 | 0.091 | 0.081 | 0.071 | 0.061 | 0.046 |
| TRF250-120 | 0.186 | 0.165 | 0.143 | 0.120 | 0.099 | 0.088 | 0.077 | 0.066 | 0.050 |
| TRF250-145 | 0.225 | 0.199 | 0.172 | 0.145 | 0.119 | 0.106 | 0.093 | 0.080 | 0.060 |
| TRF250-183‡ | 0.284 | 0.251 | 0.217 | 0.183 | 0.149 | 0.133 | 0.117 | 0.101 | 0.075 |
| NEW TRF250-184‡ | 0.286 | 0.252 | 0.218 | 0.184 | 0.150 | 0.134 | 0.118 | 0.102 | 0.075 |
| Surface-mount* — 250V_{AC} | | | | | | | | | |
| TS250/TSL250/TSV250 | | | | | | | | | |
| TSL250-080F | 0.124 | 0.110 | 0.095 | 0.080 | 0.066 | 0.059 | 0.051 | 0.044 | 0.033 |
| TS250-130F | 0.208 | 0.182 | 0.156 | 0.130 | 0.104 | 0.091 | 0.078 | 0.065 | 0.045 |
| TSV250-130F | 0.208 | 0.182 | 0.156 | 0.130 | 0.104 | 0.091 | 0.078 | 0.065 | 0.045 |
| Radial-led† — 600V_{AC} | | | | | | | | | |
| TRF600 | | | | | | | | | |
| TRF600-150 | 0.239 | 0.209 | 0.180 | 0.150 | 0.121 | 0.107 | 0.093 | 0.079 | 0.057 |
| TR600-150F-EX | 0.239 | 0.209 | 0.180 | 0.150 | 0.121 | 0.107 | 0.093 | 0.079 | 0.057 |
| TR600-150F-EX-RA | 0.239 | 0.209 | 0.180 | 0.150 | 0.121 | 0.107 | 0.093 | 0.079 | 0.057 |
| TRF600-160 | 0.255 | 0.223 | 0.192 | 0.160 | 0.129 | 0.114 | 0.099 | 0.084 | 0.061 |
| NEW TRF600-400 | 0.640 | 0.560 | 0.480 | 0.400 | 0.320 | 0.270 | 0.230 | 0.190 | 0.130 |
| Surface-mount† — 600V_{AC} | | | | | | | | | |
| TS600/TSM600 | | | | | | | | | |
| TS600-170F | 0.264 | 0.230 | 0.200 | 0.170 | 0.140 | 0.125 | 0.109 | 0.094 | 0.070 |
| TS600-200F-RA-B-0.5 | 0.310 | 0.275 | 0.238 | 0.200 | 0.165 | 0.147 | 0.128 | 0.110 | 0.083 |
| TS600-400F | 0.640 | 0.560 | 0.480 | 0.400 | 0.320 | 0.270 | 0.230 | 0.190 | 0.130 |
| TSM600-250F | 0.400 | 0.350 | 0.300 | 0.250 | 0.198 | 0.170 | 0.140 | 0.117 | 0.083 |
| TSM600-250F-RA | 0.400 | 0.350 | 0.300 | 0.250 | 0.198 | 0.170 | 0.140 | 0.117 | 0.083 |
| TSM600-400F | 0.640 | 0.560 | 0.480 | 0.400 | 0.320 | 0.270 | 0.230 | 0.190 | 0.130 |

* 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

† 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

‡ Product is not currently available in a resistance matched or sorted option.

Figure T1 Thermal Derating [Hold Current (A) at Ambient Temperature (°C)]

- A = TCF250-180
- B = All other TCF, TRF, TSx, TSM series devices

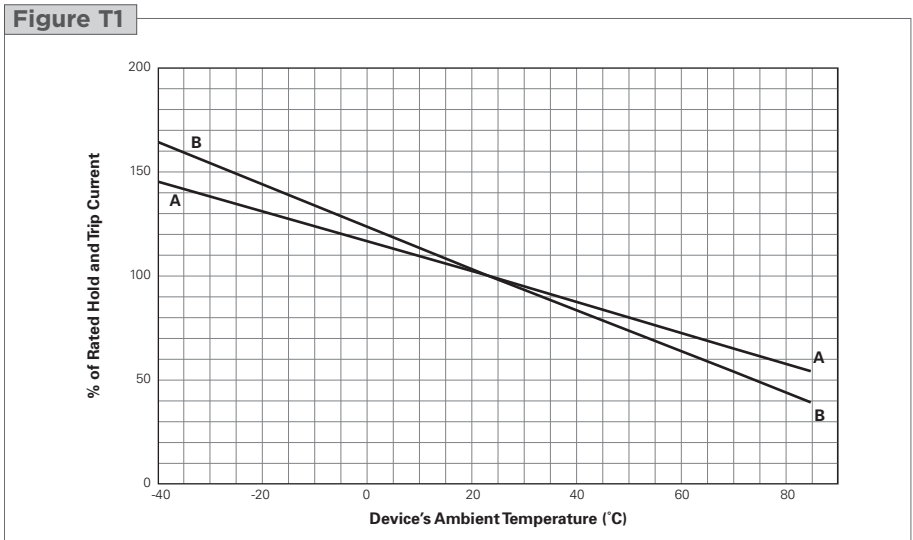


Table T3 Electrical Characteristics for Telecommunications and Networking Devices

| Part Number | I _H (A) | I _T (A) | V _{MAX} | | I _{MAX} *† (A) | P _D Typ (W) | Typical Time-to-trip | | R _{MIN} (Ω) | R _{MAX} (Ω) | R _{1MAX} (Ω) |
|---|--------------------|--------------------|------------------------------|-------------------------------|-------------------------|------------------------|----------------------|------|----------------------|----------------------|-----------------------|
| | | | Operating (V _{DC}) | Interrupt (V _{RMS}) | | | (A) | (s) | | | |
| Chip* — 250V_{AC} | | | | | | | | | | | |
| TCF250 | | | | | | | | | | | |
| TCF250-100T | 0.100 | 0.150 | 60 | 250 | 3.0 | 0.6 | 1.0 | 0.2 | 14.0 | 18.0 | 24.0 |
| TCF250-120T | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.0 | 0.6 | 6.3 | 12.0 | 18.0 |
| TCF250-145T | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.0 | 1.5 | 5.0 | 9.0 | 14.0 |
| TCF250-180† | 0.180 | 0.650 | 60 | 250 | 3.0 | 0.9 | 1.0 | 15.5 | 1.0 | 2.2 | 4.0 |
| Radial-leaded* — 250V_{AC} | | | | | | | | | | | |
| TRF250 | | | | | | | | | | | |
| NEW TRF250-055UT | 0.055 | 0.170 | 60 | 250 | 3.0 | 0.6 | 0.28 | 3.0 | 15.0 | 25.0 | 35.0 |
| TRF250-080T | 0.080 | 0.160 | 60 | 250 | 3.0 | 0.6 | 0.35 | 2.5 | 15.0 | 22.0 | 33.0 |
| TRF250-080U | 0.080 | 0.160 | 60 | 250 | 3.0 | 0.6 | 0.35 | 2.5 | 14.0 | 20.0 | 33.0 |
| TRF250-110U | 0.110 | 0.220 | 60 | 250 | 3.0 | 1.0 | 1.00 | 0.8 | 5.0 | 9.0 | 16.0 |
| TRF250-120 | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.5 | 4.0 | 8.0 | 16.0 |
| TRF250-120T | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 0.35 | 0.7 | 7.0 | 12.0 | 16.0 |
| TRF250-120FRA | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.2 | 7.0 | 9.0 | 16.0 |
| TRF250-120FRC | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.5 | 5.4 | 7.5 | 14.0 |
| TRF250-120FRF | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 0.9 | 6.0 | 10.5 | 16.0 |
| TRF250-120FR1 | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.0 | 6.0 | 9.0 | 16.0 |
| TRF250-120FR2 | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 0.8 | 8.0 | 10.5 | 16.0 |
| TRF250-120U | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.0 | 6.0 | 10.0 | 16.0 |
| TRF250-120UT | 0.120 | 0.240 | 60 | 250 | 3.0 | 1.0 | 1.00 | 0.7 | 7.0 | 12.0 | 16.0 |
| TRF250-145 | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.00 | 2.5 | 3.0 | 6.0 | 14.0 |
| TRF250-145-RA | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.00 | 2.5 | 3.0 | 5.5 | 12.0 |
| TRF250-145-RB | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.00 | 2.0 | 4.5 | 6.0 | 14.0 |
| TRF250-145T | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.00 | 1.5 | 5.4 | 7.5 | 14.0 |
| TRF250-145U | 0.145 | 0.290 | 60 | 250 | 3.0 | 1.0 | 1.00 | 2.0 | 3.5 | 6.5 | 14.0 |
| TRF250-183† | 0.183 | 0.685 | 100 | 250 | 10.0 | 0.9 | 3.00 | 0.6 | 0.8 | 2.2 | 3.4 |
| NEW TRF250-184† | 0.184 | 1.000 | 100 | 250 | 10.0 | 0.9 | 3.00 | 0.5 | 1.2 | 2.4 | 3.1 |
| Surface-mount* — 250V_{AC} | | | | | | | | | | | |
| TS250/TSL250/TSV250 | | | | | | | | | | | |
| TSL250-080F | 0.080 | 0.240 | 80 | 250 | 3.0 | 1.2 | 1.0 | 0.8 | 5.0 | 11.0 | 20.0** |
| TS250-130F | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.1 | 1.0 | 0.9 | 6.5 | 12.0 | 20.0** |
| | — | — | 60 | 600 | 1.0 | — | — | — | — | — | — |
| TS250-130F-RA | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.1 | 1.0 | 1.4 | 6.5 | 9.0 | 15.0** |
| | — | — | 60 | 600 | 1.0 | — | — | — | — | — | — |
| TS250-130F-RB | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.1 | 1.0 | 0.7 | 9.0 | 12.0 | 20.0** |
| | — | — | 60 | 600 | 1.0 | — | — | — | — | — | — |
| TS250-130F-RC | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.1 | 1.0 | 1.1 | 7.0 | 10.0 | 17.0** |
| | — | — | 60 | 600 | 1.0 | — | — | — | — | — | — |
| TSV250-130F | 0.130 | 0.260 | 60 | 250 | 3.0 | 1.5 | 1.0 | 2.0 | 4.0 | 7.0 | 12.0** |
| Radial-leaded† — 600V_{AC} | | | | | | | | | | | |
| TRF600 | | | | | | | | | | | |
| TRF600-150 | 0.150 | 0.300 | 250 | 600 | 3.0 | 1.0 | 1.0 | 1.4 | 6.0 | 10.0 | 17.0 |
| TRF600-150-RB | 0.130 | 0.260 | 250 | 600 | 3.0 | 1.0 | 1.0 | 1.0 | 9.0 | 12.0 | 22.0 |
| TR600-150F-EX | 0.150 | 0.300 | 250 | 600 | 3.0 | 1.4 | 1.0 | 5.0 | 6.0 | 12.0 | 22.0 |
| TR600-150F-EX-RA-B-0.5 | 0.150 | 0.300 | 250 | 600 | 3.0 | 1.4 | 1.0 | 5.0 | 7.0 | 10.0 | 20.0 |
| TRF600-160 | 0.160 | 0.320 | 250 | 600 | 3.0 | 1.7 | 1.0 | 7.5 | 4.0 | 10.0 | 18.0 |
| TRF600-160-RA | 0.160 | 0.320 | 250 | 600 | 3.0 | 1.7 | 1.0 | 9.5 | 4.0 | 7.0 | 16.0 |
| TRF600-160-R1 | 0.160 | 0.320 | 250 | 600 | 3.0 | 1.7 | 1.0 | 9.0 | 4.0 | 8.0 | 17.0 |
| NEW TRF600-400 | 0.400 | 1.000 | 60 | 600 | 3.0 | 2.4 | 3.0 | 4.0 | 0.95 | 1.45 | 1.90 |

 * 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

 † 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

‡ Product is not currently available in a resistance matched or sorted option.

 ** R_{1MAX} measured 1 hour post-trip, or 24 hours post-reflow at 20°C.

| Part Number | I _H (A) | I _T (A) | V _{MAX} | | I _{MAX} *† (A) | P _D Typ (W) | Typical Time-to-trip | | R _{MIN} (Ω) | R _{MAX} (Ω) | R _{1MAX} (Ω) |
|--|--------------------|--------------------|------------------------------|-------------------------------|-------------------------|------------------------|----------------------|------|----------------------|----------------------|-----------------------|
| | | | Operating (V _{DC}) | Interrupt (V _{RMS}) | | | (A) | (s) | | | |
| Surface-mount[†] — 600V_{AC} | | | | | | | | | | | |
| TS600/TSM600 | | | | | | | | | | | |
| TS600-170F | 0.170 | 0.400 | 60 | 600 | 3.0 | 2.5 | 1.0 | 10.0 | 4.0 | 9.0 | 18.0 |
| TS600-200F-RA-B-0.5 | 0.200 | 0.400 | 60 | 600 | 3.0 | 2.5 | 1.0 | 12.0 | 4.0 | 7.5 | 13.5 |
| TS600-400F | 0.400 | 1.000 | 60 | 600 | 3.0 | 2.0 | 3.0 | 5.0 | 0.5 | 1.5 | 2.0 |
| TSM600-250F | 0.250 | 0.860 | 250 | 600 | 3.0 | 2.0 | 3.0 | 0.8 | 1.0 | 3.5 | 7.0 |
| TSM600-250F-RA | 0.250 | 0.860 | 250 | 600 | 3.0 | 2.0 | 3.0 | 1.0 | 1.0 | 3.0 | 5.0 |
| TSM600-400F | 0.400 | 1.000 | 250 | 600 | 3.0 | 2.0 | 3.0 | 5.0 | 0.5 | 1.5 | 2.0 |

Notes:

- I_H : Hold current: maximum current device will pass without interruption in 20°C still air.
- I_T : Trip current: minimum current that will switch the device from low resistance to high resistance in 20°C still air.
- V_{MAX} Operating : Maximum continuous voltage device can withstand without damage at rated current. This voltage is used for component recognition under UL1434.
- V_{MAX} Interrupt : Maximum voltage that can be safely placed across a device in its tripped state. Devices have been designed to trip safely under higher level power cross conditions to assist equipment in meeting the appropriate ITU, UL60950, or GR1089 industry requirements.
- I_{MAX} Interrupt : Maximum fault current device can withstand without damage at rated operating voltage. This current is used for component recognition under UL1434. Devices have been designed to trip safely under higher level power cross conditions to assist equipment in meeting the appropriate ITU, UL60950, or GR1089 industry requirements.
- P_D : Power dissipated from device when in the tripped state in 20°C still air.
- R_{MIN} : Minimum resistance of device as supplied at 20°C unless otherwise specified.
- R_{MAX} : Maximum resistance of device as supplied at 20°C unless otherwise specified.
- R_{1MAX} : Maximum resistance measured one hour post-trip or post-reflow at 20°C.

* 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.
 † 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

Warning :

- Users should independently evaluate the suitability of and test each product selected for their own application.
- Operation beyond the maximum ratings or improper use may result in device damage and possible electrical arcing and flame.
- These devices are intended for protection against damage caused by occasional overcurrent or overtemperature fault conditions and should not be used when repeated fault conditions or prolonged trip events are anticipated.
- Contamination of the PPTC material with certain silicone-based oils or some aggressive solvents can adversely impact the performance of the devices.
- Device performance can be impacted negatively if devices are handled in a manner inconsistent with recommended electronic, thermal, and mechanical procedures for electronic components.
- PPTC devices are not recommended for installation in applications where the device is constrained such that its PTC properties are inhibited, for example in rigid potting materials or in rigid housings, which lack adequate clearance to accommodate device expansion.
- Operation in circuits with a large inductance can generate a circuit voltage (Ldi/dt) above the rated voltage of the device.

Figure T2-T13 Dimension Figures for Telecommunications and Networking Devices

12

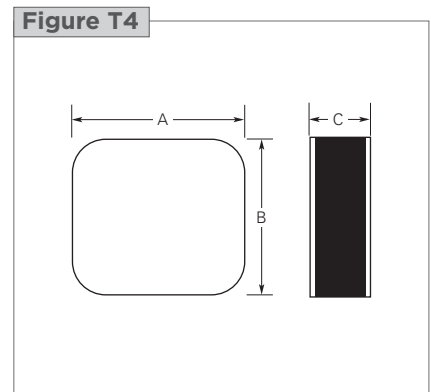
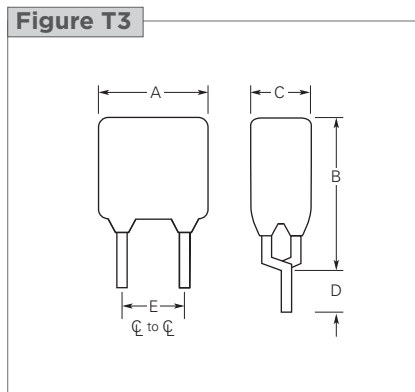
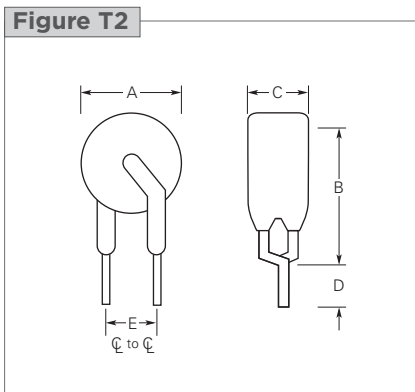


Figure T5

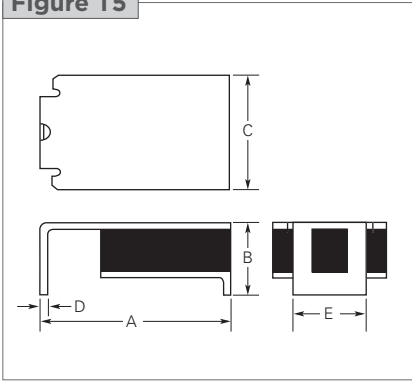


Figure T6

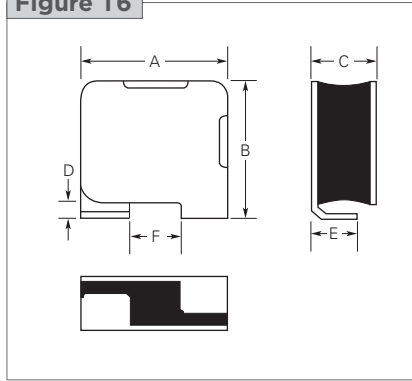


Figure T7

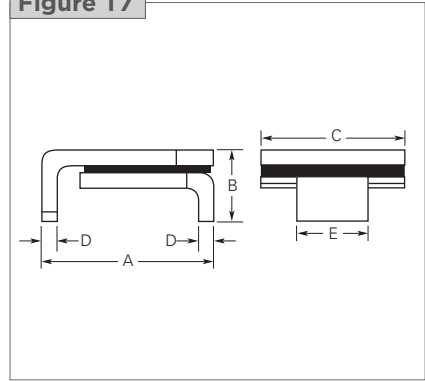


Figure T8

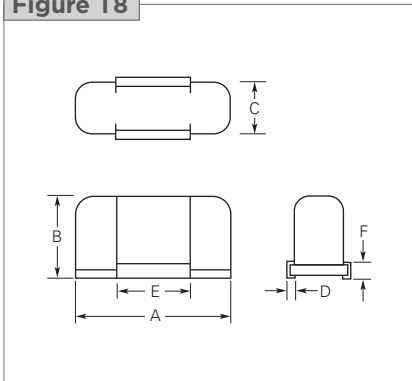


Figure T9

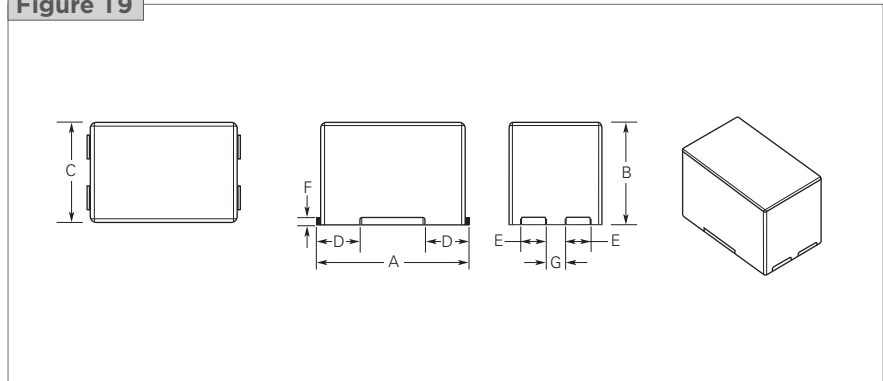


Figure T10

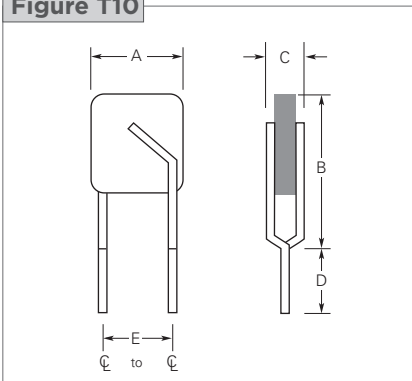


Figure T11

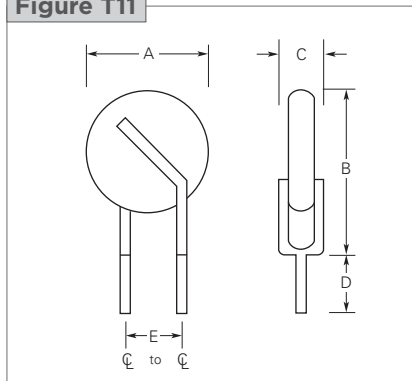


Figure T12

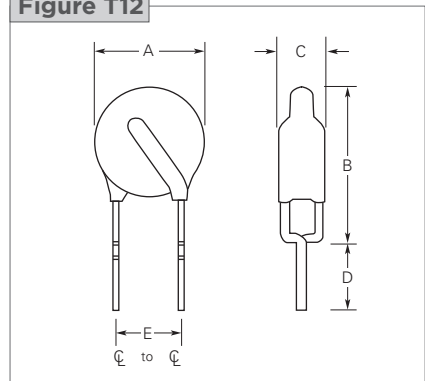


Figure T13

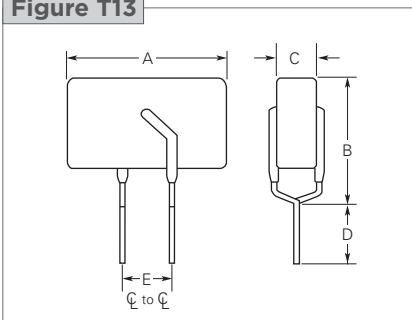


Table T4 Dimensions & Weights for Telecommunications and Networking Devices

| Part Number | Dimensions in Millimeters (Inches) | | | | | | | | | | | | | | Figure | Device Mass (g) (Only for reference) |
|----------------------------|------------------------------------|----------------|---------------|----------------|---------------|---------------|----------------------------|---------------|----------------------------|---------------|---------------|----------------|------|------|--------|---|
| | A | | B | | C | | D | | E | | F | | G | | | |
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | | |
| TCF | | | | | | | | | | | | | | | | |
| 250V* | | | | | | | | | | | | | | | | |
| TCF250-100T | 4.6 (0.18) | 4.9 (0.19) | 4.6 (0.18) | 4.9 (0.19) | 2.0 (0.08) | 2.3 (0.09) | — | — | — | — | — | — | — | — | T4 | 0.24 |
| TCF250-120T | 5.4 (0.21) | 5.6 (0.22) | 5.4 (0.21) | 5.6 (0.22) | 2.0 (0.08) | 2.3 (0.09) | — | — | — | — | — | — | — | — | T4 | 0.28 |
| TCF250-145T | 5.4 (0.21) | 5.6 (0.22) | 5.4 (0.21) | 5.6 (0.22) | 2.0 (0.08) | 2.5 (0.10) | — | — | — | — | — | — | — | — | T4 | 0.28 |
| TCF250-180 | 6.9 (0.27) | 7.1 (0.28) | 6.9 (0.27) | 7.1 (0.28) | 1.3 (0.05) | 1.6 (0.06) | — | — | — | — | — | — | — | — | T4 | 0.35 |
| TRF250 | | | | | | | | | | | | | | | | |
| 250V* | | | | | | | | | | | | | | | | |
| NEW TRF250-055UT | — | 4.8 (0.19) | — | 9.3 (0.37) | — | 3.8 (0.15) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T2 | 0.13 |
| TRF250-080T | — | 5.8 (0.23) | — | 9.9 (0.39) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T2 | 0.28 |
| TRF250-080U | — | 4.8 (0.19) | — | 9.3 (0.37) | — | 3.8 (0.15) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T11 | 0.13 |
| TRF250-110U | — | 5.3 (0.21) | — | 9.4 (0.37) | — | 3.8 (0.15) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T11 | 0.13 |
| TRF250-120 | — | 6.5 (0.26) | — | 11.0 (0.43) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T3 | 0.38 |
| TRF250-120U | — | 6.0 (0.24) | — | 10.0 (0.39) | — | 3.8 (0.15) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T10 | 0.19 |
| TRF250-145 | — | 6.5 (0.26) | — | 11.0 (0.43) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T3 | 0.38 |
| TRF250-145U | — | 6.0 (0.24) | — | 10.0 (0.39) | — | 3.8 (0.15) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T10 | 0.19 |
| TRF250-183 | — | 7.5 (0.29) | — | 10.5 (0.41) | — | 4.1 (0.16) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T2 | 0.30 |
| NEW TRF250-184 | — | 7.7 (0.30) | — | 10.5 (0.41) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T12 | 0.32 |
| TS250/TSL250/TSV250 | | | | | | | | | | | | | | | | |
| 250V* | | | | | | | | | | | | | | | | |
| TSL250-080F | 6.7 (0.27) | 7.9 (0.31) | 2.7 (0.11) | 3.7 (0.15) | 4.8 (0.19) | 5.3 (0.21) | 0.2 (0.01) | 0.4 (0.02) | 2.5 (0.10) | 3.1 (0.12) | — | — | — | — | T7 | 2.80 |
| TS250-130F | 8.5 (0.34) | 9.4 (0.37) | — | 3.4 (0.14) | — | 7.4 (0.29) | 0.3 [‡] (0.01) | — | 3.8 [‡] (0.15) | — | — | — | — | — | T5 | 3.60 |
| TSV250-130F | — | 6.1 (0.24) | — | 6.9 (0.27) | — | 3.2 (0.13) | 0.56 (0.02) | — | — | 1.9 (0.08) | 1.6 (0.07) | 2.3 (0.09) | — | — | T6 | 2.80 |
| TRF600 | | | | | | | | | | | | | | | | |
| 600V[†] | | | | | | | | | | | | | | | | |
| TRF600-150 | — | 9.0 (0.35) | — | 12.5 (0.49) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 (0.20) | — | — | 9.0 (0.35) | — | — | T3 | 0.37 |
| TR600-150F-EX | — | 13.5 (0.53) | — | 12.6 (0.50) | — | 6.0 (0.18) | 4.7 (0.19) | — | 5.0 (0.20) | — | — | — | — | — | T3 | 0.80 |
| TR600-150F-EX-RA-B-0.5 | — | 13.5 (0.53) | — | 12.6 (0.50) | — | 6.0 (0.18) | 4.7 (0.19) | — | 5.0 (0.20) | — | — | — | — | — | T3 | 0.80 |
| TRF600-160 | — | 16.0 (0.63) | — | 12.6 (0.50) | — | 6.0 (0.24) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | 10.0 (0.39) | — | — | T3 | 0.90 |
| NEW TRF600-400 | — | 14.8 (0.58) | — | 13.1 (0.52) | — | 4.6 (0.18) | 4.7 (0.19) | — | 5.0 [‡] (0.20) | — | — | — | — | — | T13 | 0.85 |

* 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

† 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

‡ Indicates dimension is typical, not minimum.

Table T4 Dimensions & Weights for Telecommunications and Networking Devices

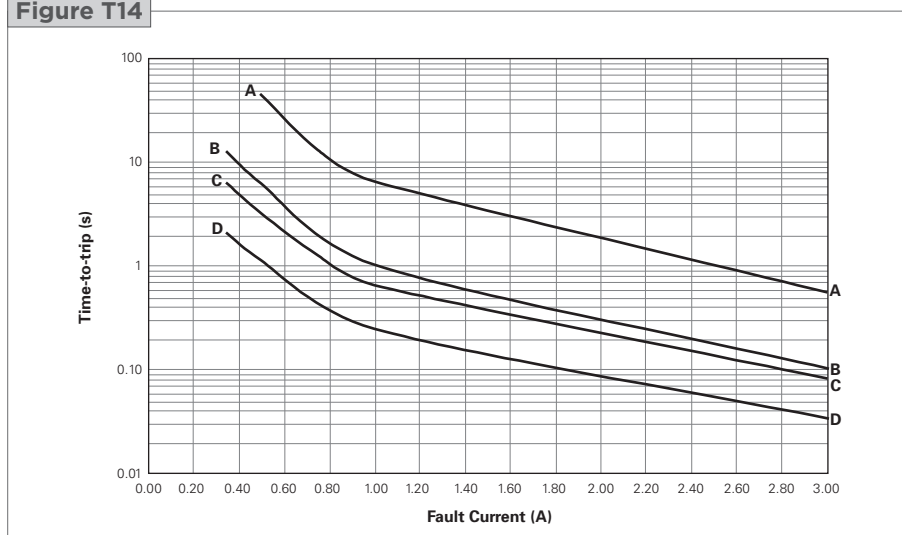
Cont'd

| Part Number | Dimensions in Millimeters (Inches) | | | | | | | | | | | | | | Figure | Device Mass (g) (Only for reference) | |
|-------------------------------|------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|---------------|---------------|---------------|--------|---|--|
| | A | | B | | C | | D | | E | | F | | G | | | | |
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | | | |
| TS600/TSM600 600V† | | | | | | | | | | | | | | | | | |
| TS600-170F | 18.3 (0.72) | 19.4 (0.77) | 11.6 (0.46) | 12.3 (0.49) | 7.2 (0.29) | 8.3 (0.33) | 1.7 (0.07) | 2.4 (0.10) | 9.9 (0.39) | 10.4 (0.41) | 1.5 (0.06) | 2.3 (0.09) | — | — | T8 | 23.6 | |
| TS600-200F-RA | 18.3 (0.72) | 19.4 (0.77) | 11.6 (0.46) | 12.3 (0.49) | 7.2 (0.29) | 8.3 (0.33) | 1.7 (0.07) | 2.4 (0.10) | 9.9 (0.39) | 10.4 (0.41) | 1.5 (0.06) | 2.3 (0.09) | — | — | T8 | 23.6 | |
| TS600-400F | 18.3 (0.72) | 19.4 (0.77) | 11.6 (0.46) | 12.3 (0.49) | 7.2 (0.29) | 8.3 (0.33) | 1.7 (0.07) | 2.4 (0.10) | 9.9 (0.39) | 10.4 (0.41) | 1.5 (0.06) | 2.3 (0.09) | — | — | T8 | 19.8 | |
| TSM600-250F | 17.00 (0.67) | 17.60 (0.69) | 11.20 (0.44) | 11.70 (0.46) | 10.40 (0.41) | 11.20 (0.44) | 4.80 (0.19) | 5.20 (0.20) | 2.50 (0.10) | 2.80 (0.11) | 0.60 (0.02) | 1.0 (0.04) | 2.2 (0.09) | 3.1 (0.12) | T9 | 31.2 | |
| TSM600-250F-RA | 17.00 (0.67) | 17.60 (0.69) | 11.20 (0.44) | 11.70 (0.46) | 10.40 (0.41) | 11.20 (0.44) | 4.80 (0.19) | 5.20 (0.20) | 2.50 (0.10) | 2.80 (0.11) | 0.60 (0.02) | 1.0 (0.04) | 2.2 (0.09) | 3.1 (0.12) | T9 | 31.2 | |
| TSM600-400F | 17.00 (0.67) | 17.60 (0.69) | 11.20 (0.44) | 11.70 (0.46) | 10.40 (0.41) | 11.20 (0.44) | 4.80 (0.19) | 5.20 (0.20) | 2.50 (0.10) | 2.80 (0.11) | 0.60 (0.02) | 1.0 (0.04) | 2.2 (0.09) | 3.1 (0.12) | T9 | 31.2 | |

 † 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

Figure T14-T17 Typical Time-to-trip Curves at 20°C for Telecommunications and Networking Devices
TCF250

- A = TCF250-180
- B = TCF250-145T
- C = TCF250-120T
- D = TCF250-100T

Figure T14

TRF250

- A = TRF250-180/183/184
- B = TRF250-145/145U
- C = TRF250-120/120U
- D = TRF250-110U/120UT/120T
- E = TRF250-080T/080U/080US

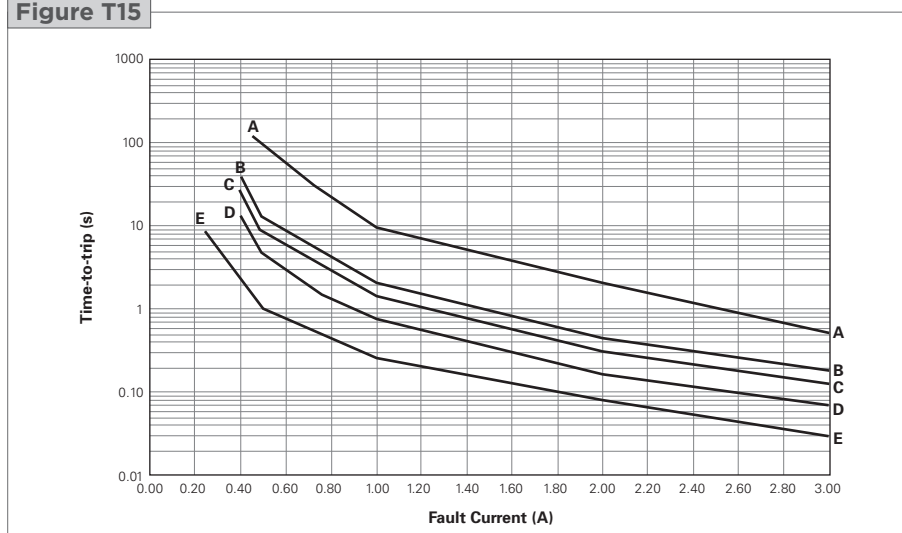
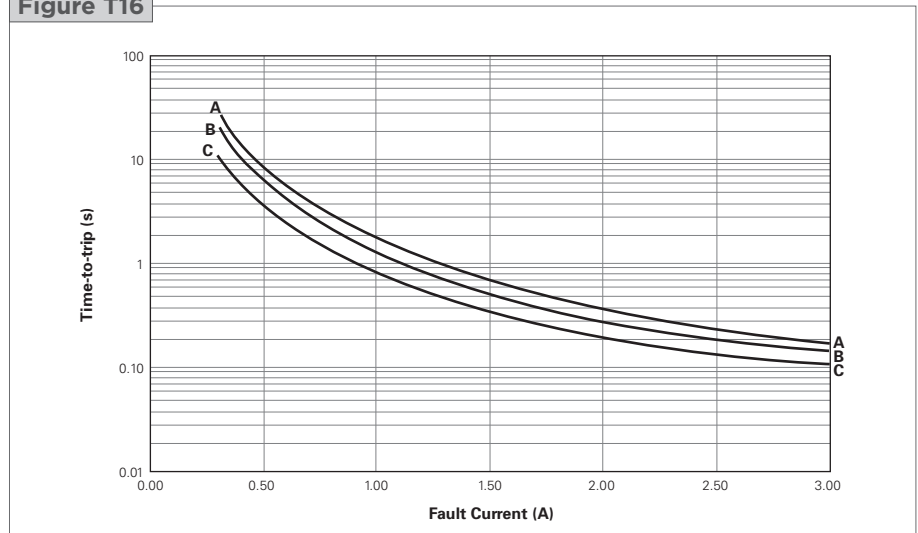
Figure T15


Figure T14-T17 Typical Time-to-trip Curves at 20°C for Telecommunications and Networking Devices Cont'd

TS250/TSV250/TSL250

- A = TSV250-130F
- B = TS250-130F
- C = TSL250-080F

Figure T16



TRF600/TS600/TSM600

- A = TRF600-400/TS600-400/
TSM600-400F
- B = TSM600-250F/
TS600-170F/200F
- C = TRF600-160
- D = TR600-150F-EX
- E = TRF600-150

Figure T17

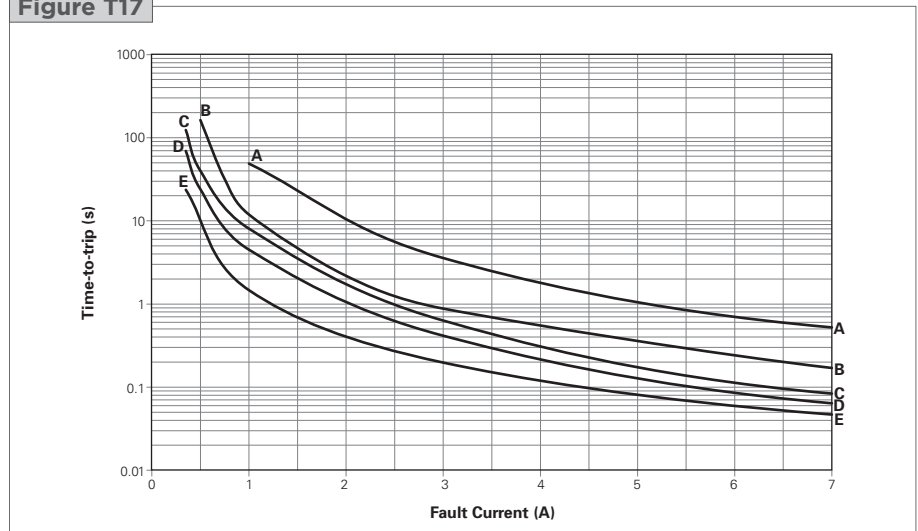


Table T5 Physical Characteristics and Environmental Specifications for Telecommunications and Networking Devices

Operating temperature range for all listed products is -40°C to 85°C, except for TRF250-080T and TRF250-184 (0°C to 85°C)

TCF250*

Physical Characteristics

Terminal material Nickel-plated copper foil

Environmental Specifications

| Test | Conditions |
|--------------------|--------------------------------------|
| Passive aging | 60°C, 1000 hours 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 1000 hours |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215F |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

* 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

Table T5 Physical Characteristics and Environmental Specifications for Telecommunications and Networking Devices

Cont'd

Operating temperature range for all listed products is -40°C to 85°C, except for TRF250-080T and TRF250-184 (0°C to 85°C)
TRF250*
Physical Characteristics

| | |
|---------------------------|---|
| Lead material | Tin-plated copper, 22AWG |
| Insulating material | Cured epoxy polymer |
| Flammability | per IEC 695-2-2 Needle Flame Test for 20s |
| Soldering characteristics | ANSI/J-STD-002, Category 3 |
| Solder heat withstand | IEC-STD 68-2-20, Test Tb, Section 5 Method 1A, Condition B: can withstand 10 seconds at 260°C±5°C |

Note: Devices are not designed to be placed through a reflow process.

Environmental Specifications

| Test | Conditions |
|--------------------|--------------------------|
| Passive aging | 60°C, 1000 hours |
| | 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 1000 hours |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215F |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TS250/TSV250/TSL250*
Physical Characteristics

| | |
|---------------------------|--|
| Terminal material | Tin-plated brass, Nickel under-plating |
| Soldering characteristics | EIC 60008-2-58 |

Environmental Specifications

| Test | Conditions |
|--------------------|--------------------------|
| Passive aging | 60°C, 1000 hours |
| | 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 500 hours |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215F |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TRF600†
Physical Characteristics

| | |
|---------------------------|---|
| Lead material | Tin-plated copper, 22AWG |
| Insulating material | Cured epoxy polymer [‡] |
| Flammability | per IEC 695-2-2 Needle flame test for 20s |
| Soldering characteristics | ANSI/J-STD-002, Category 3 |
| Solder heat withstand | IEC-STD 68-2-20, Test Tb, Section 5 Method 1A, Condition B: can withstand 10 seconds at 260°C±5°C |

Note: Devices are not designed to be placed through a reflow process.

Environmental Specifications

| Test | Conditions |
|--------------------|---------------------------------------|
| Passive aging | 60°C, 1000 hours |
| | 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 1000 hours [‡] |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215F |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

 * 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

 † 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

‡ Excluding TRF600-150 and TRF600-400, which have a coating that is not rated for dielectric withstand and can withstand 500h at 85°C/85% RH or 1000h at 60°C/90% RH.

Operating temperature range for all listed products is -40°C to 85°C, except for TRF250-080T and TRF250-184 (0°C to 85°C)

TS600[†]
Physical Characteristics

| | |
|---------------------------|--|
| Terminal material | Tin-plated brass |
| Insulating material | Nylon resin (UL94V-0), 1000V dielectric rating |
| Flammability | IEC 695-2-2 Needle Flame Test for 20s |
| Soldering characteristics | ANSI/J-STD-002, Category 3 |
| Solder heat withstand | IEC-STD 68-2-20, Test Tb, Section 5 Method 1A |

Environmental Specifications

| Test | Conditions |
|--------------------|--------------------------|
| Passive aging | 60°C, 1000 hours |
| | 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 1000 hours |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215F |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

TSM600[†]
Physical Characteristics

| | |
|---------------------------|--|
| Terminal material | Tin-plated brass |
| Insulating material | Nylon resin (UL94V-0), 1000V dielectric rating |
| Flammability | IEC 695-2-2 Needle Flame Test for 20s |
| Soldering characteristics | EIC60068-2-58, Method 7 |
| Solder heat withstand | IEC-STD 68-2-20, Test Tb, Section 5 Method 1A |

Environmental Specifications

| Test | Conditions |
|--------------------|-----------------------------------|
| Passive aging | 60°C, 1000 hours |
| | 85°C, 1000 hours |
| Humidity aging | 85°C, 85% RH, 1000 hours |
| Storage humidity | Per IPC/JEDEC J-STD-020A Level 2a |
| Thermal shock | 125°C, -55°C (10 times) |
| Solvent resistance | MIL-STD-202, Method 215J |

Note: Storage conditions: 40°C max., 70% RH max., devices should remain in original sealed bag prior to use. Devices may not meet specified values if these storage conditions are exceeded.

[†] 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

Table T6 Packaging and Marking Information for Telecommunications and Networking Devices

| Part Number | Bag Quantity | Tape & Reel Quantity | Standard Package Quantity | Part Marking | Agency Recognition |
|---|--------------|----------------------|---------------------------|--------------|--------------------|
| Chip* — 250V_{AC} | | | | | |
| TCF250 | | | | | |
| TCF250-100T | 2,500 | — | 10,000 | — | — |
| TCF250-120T | 2,500 | — | 10,000 | — | — |
| TCF250-145T | 2,500 | — | 10,000 | — | — |
| TCF250-180 | 2,500 | — | 10,000 | — | UL |
| Radial-leaded* — 250V_{AC} | | | | | |
| TRF250 | | | | | |
| NEW TRF250-055UT | 500 | — | 10,000 | — | — |
| TRF250-080U | 500 | — | 10,000 | — | UL, CSA, TÜV |
| TRF250-080U-2 | — | 1,500 | 7,500 | — | UL, CSA, TÜV |
| TRF250-080T | 500 | — | 10,000 | 08F | UL, CSA, TÜV |
| TRF250-110U | 500 | — | 10,000 | — | UL, CSA, TÜV |
| TRF250-120 | 500 | — | 10,000 | 20F | UL, CSA, TÜV |
| TRF250-120-2 | — | 1,500 | 7,500 | 20F | UL, CSA, TÜV |
| TRF250-120T | 500 | — | 10,000 | 20F | UL, CSA, TÜV |
| TRF250-120T-2 | — | 1,500 | 7,500 | 20F | UL, CSA, TÜV |
| TRF250-120U | 500 | — | 10,000 | 20F | UL, CSA, TÜV |
| TRF250-120U-2 | — | 1,500 | 7,500 | 20F | UL, CSA, TÜV |
| TRF250-120UT | 500 | — | 10,000 | 20F | UL, CSA, TÜV |
| TRF250-145 | 500 | — | 10,000 | 45F | UL, CSA, TÜV |
| TRF250-145-2 | — | 1,500 | 7,500 | 45F | UL, CSA, TÜV |
| TRF250-145-RA | 500 | — | 10,000 | 45F | UL, CSA, TÜV |
| TRF250-145U | 500 | — | 10,000 | 45F | UL, CSA, TÜV |
| TRF250-145U-2 | — | 1,500 | 7,500 | 45F | UL, CSA, TÜV |
| TRF250-183 | 500 | — | 10,000 | 83F | UL, CSA, TÜV |
| TRF250-183-2 | — | 1,500 | 7,500 | 83F | UL, CSA, TÜV |
| NEW TRF250-184 | 500 | — | 10,000 | 84F | UL, CSA, TÜV |
| Surface-mount* — 250V_{AC} | | | | | |
| TS250/TSL250/TSV250 | | | | | |
| TSL250-080F-2 | — | 1,500 | 7,500 | T08 | UL, CSA, TÜV |
| TS250-130F-2 | — | 1,500 | 7,500 | T13 | UL, CSA, TÜV |
| TSV250-130F-2 | — | 1,200 | 6,000 | T13V | UL, CSA, TÜV |
| Radial-leaded† — 600V_{AC} | | | | | |
| TRF600 | | | | | |
| TRF600-150 | 500 | — | 10,000 | 150F | UL, CSA, TÜV |
| TRF600-150-2 | — | 1,500 | 7,500 | 150F | UL, CSA, TÜV |
| TR600-150F-EX | 500 | — | 10,000 | 150F | UL, CSA |
| TR600-150F-EX-2 | — | 600 | 3,000 | 150F | UL, CSA |
| TR600-150F-EX-RA-B-0.5 | 500 | — | 10,000 | 150F | UL, CSA |
| TRF600-160 | 500 | — | 10,000 | 160F | UL, CSA, TÜV |
| TRF600-160-2 | — | 600 | 3,000 | 160F | UL, CSA, TÜV |
| NEW TRF600-400 | 500 | — | 10,000 | 400F | UL, CSA |
| Surface-mount† — 600V_{AC} | | | | | |
| TSM600/TSM600 | | | | | |
| TS600-170F-2 | — | 300 | 900 | T20 | UL, CSA |
| TS600-200F-RA-2 | — | 300 | 900 | T20 | UL, CSA |
| TS600-400F-2 | — | 300 | 900 | T40 | UL, CSA |
| TSM600-250F-2 | — | 200 | 1,000 | TSM600 | UL, CSA |
| TSM600-250F-RA-2 | — | 200 | 1,000 | TSM600 | UL, CSA |
| TSM600-400F-2 | — | 200 | 1,000 | TSM600 | UL |

 * 250V_{AC} interrupt products are designed to help equipment pass ITU K.20, K.21, & K.45 recommendations and Telcordia GR-1089 Port Type 2 & 4 requirements.

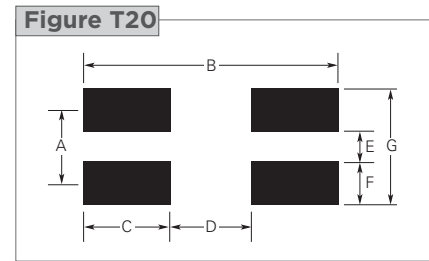
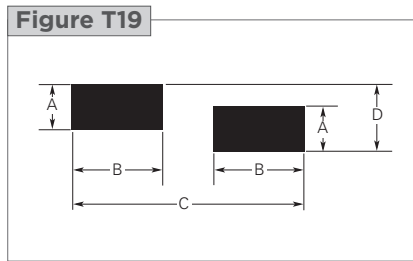
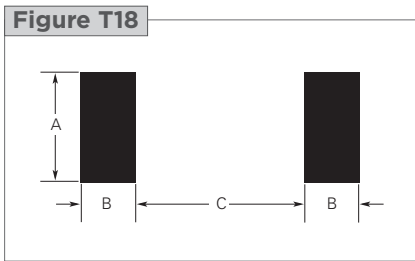
 † 600V_{AC} interrupt products are designed to help equipment pass UL60950, TIA-968-A and GR1089 Port Type 1, 3 & 5 requirements.

Agency Recognition for Telecommunications and Networking Devices

| | | |
|-----|----------------|---|
| UL | File # E74889 | |
| CSA | File #78165C | |
| TÜV | Per IEC60730-1 | Certificate # for individual products available upon request. |

Table T7 Recommended Pad Layouts for Surface-mount Telecommunications and Networking Devices in millimeters (inches) Nominal

| Device | A | B | C | D | E | F | G | Figure |
|--------------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|--------|
| TS250 (All) | 4.60 (0.180) | 1.80 (0.070) | 6.10 (0.240) | — | — | — | — | T18 |
| TSV250 (All) | 2.29 (0.090) | 2.41 (0.095) | 6.35 (0.250) | 3.43 (0.135) | — | — | — | T19 |
| TSL250 (All) | 3.60 (0.140) | 1.80 (0.070) | 5.50 (0.220) | — | — | — | — | T18 |
| TS600 (All) | 10.42 (0.410) | 3.30 (0.130) | 3.35 (0.132) | — | — | — | — | T18 |
| TSM600 (All) | 5.20 (0.205) | 17.80 (0.701) | 5.54 (0.218) | 6.75 (0.266) | 2.08 (0.082) | 3.12 (0.123) | 8.39 (0.331) | T20 |



Solder Reflow and Rework Recommendations for Telecommunications Surface-mount Devices

| Profile Feature | Pb-Free Assembly |
|---|------------------|
| Average ramp up rate (T_{sMAX} to T_p) | 3°C/second max. |
| Preheat | |
| • Temperature min. (T_{sMIN}) | 150°C |
| • Temperature max. (T_{sMAX}) | 200°C |
| • Time (t_{sMIN} to t_{sMAX}) | 60-180 seconds |
| Time maintained above: | |
| • Temperature (T_L) | 217°C |
| • Time (t_L) | 60-150 seconds |
| Peak/Classification temperature (T_p) | 260°C |
| Time within 5°C of actual peak temperature | |
| Time (t_p) | 20-40 seconds |
| Ramp down rate | 6°C/second max. |
| Time 25°C to peak temperature | 8 minutes max. |

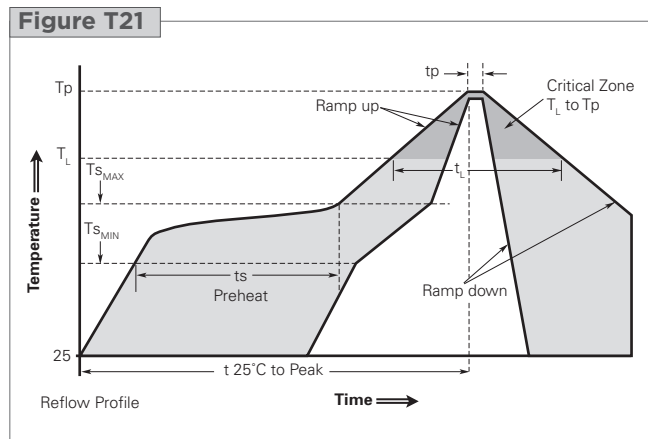
Note: All temperatures refer to topside of the package, measured on the package body surface.

Solder Reflow

- Recommended reflow method: IR, vapor phase oven, hot air oven.
- Surface-mount devices are not designed to be wave soldered to the bottom side of the board.
- Recommended maximum paste thickness of 0.25mm (0.010 in).
- Devices can be cleaned using standard industry methods and solvents.

Rework

- If a device is removed from the board, it should be discarded and replaced with a new device.



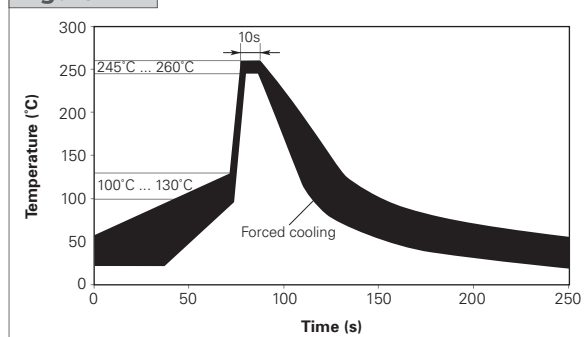
Wave Soldering and Rework Recommendations for Telecommunications Radial-leaded Devices

Recommended Wave Soldering

- Soldering temperature profile
Temperature characteristic at component terminal with dual wave soldering

Rework

- If a device is removed from the board, it should be discarded and replaced with a new device.

Figure T22

Table T8 TRF250/TRF600 Tape and Reel Specifications for Telecommunications and Networking Device

TRF250/TRF600 devices are available in tape and reel packaging per EIA 468-B standard. See Figures T23 and T24 for details.

| Dimension Description | EIA Mark | IEC Mark | Dimension (mm) | Tolerance |
|---------------------------------------|-----------------|----------------|----------------|------------|
| Carrier tape width | W | W | 18 | -0.5/+1.0 |
| Hold down tape width | W ₄ | W ₀ | 5 | Minimum |
| Top distance between tape edges | W ₆ | W ₂ | 3 | Maximum |
| Sprocket hole position | W ₅ | W ₁ | 9 | -0.5/+0.75 |
| Sprocket hole diameter | D ₀ | D ₀ | 4 | ±0.2 |
| Abcissa to plane (straight lead) | H | H | 18.5 | ±3.0 |
| Abcissa to plane (kinked lead)* | H ₀ | H ₀ | 16 | -0.5/+0.6 |
| Abcissa to top | H ₁ | H ₁ | 32.2 | Maximum |
| Overall width with lead protrusion | — | C ₁ | 43.2 | Maximum |
| Overall width without lead protrusion | — | C ₂ | 42.5 | Maximum |
| Lead protrusion | L ₁ | I ₁ | 1.0 | Maximum |
| Protrusion of cut-out | L | L | 11 | Maximum |
| Protrusion beyond hold down tape | I ₂ | I ₂ | Not specified | — |
| Sprocket hole pitch | P ₀ | P ₀ | 12.7 | ±0.3 |
| Device pitch (TRF250 & TRF600-150) | — | — | 12.7 | — |
| Device pitch (TRF600-160/400) | — | — | 25.4 | — |
| Pitch tolerance | — | — | 20 consecutive | ±1 |
| Tape thickness | t | t | 0.9 | Maximum |
| Tape thickness with splice* | t ₁ | — | 2.0 | Maximum |
| Splice sprocket hole alignment | — | — | 0 | ±0.3 |
| Body lateral deviation | Δh | Δh | 0 | ±1.0 |
| Body tape plane deviation | Δp | Δp | 0 | ±1.3 |
| Lead spacing plane deviation | ΔP ₁ | P ₁ | 0 | ±0.7 |
| Lead spacing* | F | F | 5.08 | ±0.6 |
| Reel width | w ₂ | w | 56 | Maximum |
| Reel diameter | a | d | 370 | Maximum |
| Space between flanges less device | w ₁ | — | 4.75 | ±3.25 |
| Arbor hole diameter | c | f | 26 | ±12.0 |
| Core diameter | n | h | 80 | Maximum |
| Box | — | — | 56/372/372 | Maximum |
| Consecutive missing pieces* | — | — | 3 maximum | — |
| Empty places per reel* | — | — | Not specified | — |

* Differs from EIA specification.

Figure T23 EIA Referenced Taped Component Dimensions for TRF Devices

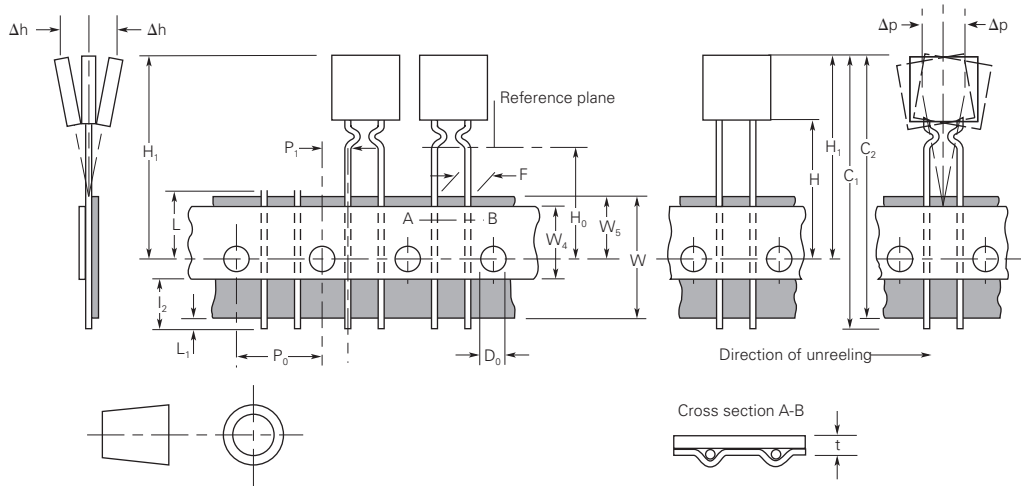


Figure T24 Reel Dimensions for TRF Devices

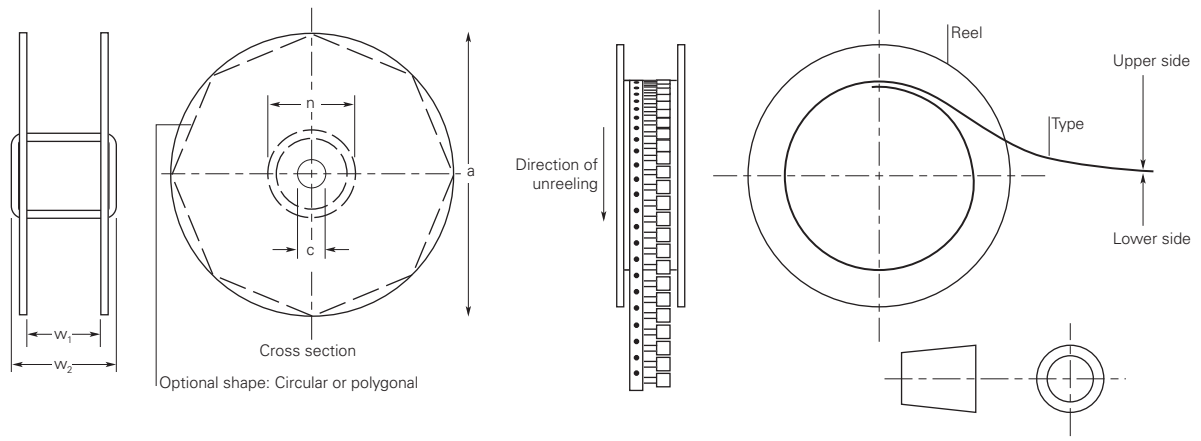


Table T9 TS Tape and Reel Specifications for Telecommunications and Networking Devices

TS devices are packaged per EIA 481 and EIA 481-2 standards. See Figures T25 and T26 for details.

TS250/TSL250/TSV250

| Dimension Description | EIA Mark | TS250 | | TSV250 | | TSL250 | |
|---|---------------------|---------------|---------------|---------------|---------------|---------------|---------------|
| | | Dimension(mm) | Tolerance(mm) | Dimension(mm) | Tolerance(mm) | Dimension(mm) | Tolerance(mm) |
| Carrier tape width | W | 16 | ±0.30 | 16.0 | ±0.30 | 16 | ±0.30 |
| Sprocket hole pitch | P ₀ | 4.0 | ±0.10 | 4.0 | ±0.10 | 4.0 | ±0.10 |
| | P ₁ | 12.0 | ±0.10 | 8.0 | ±0.10 | 8.0 | ±0.10 |
| | P ₂ | 2.0 | ±0.10 | 2.0 | ±0.10 | 2.0 | ±0.10 |
| | A ₀ | 6.9 | ±0.23 | 5.5 | ±0.10 | 5.5 | ±0.10 |
| | B ₀ | 9.6 | ±0.15 | 6.2 | ±0.10 | 7.9 | ±0.10 |
| | B ₁ max. | 12.1 | — | 8.0 | — | 9.2 | — |
| Sprocket hole diameter | D ₀ | 1.5 | -0/+0.1 | 1.55 | ±0.05 | 1.55 | ±0.05 |
| | F | 7.5 | ±0.10 | 7.5 | ±0.10 | 7.5 | ±0.10 |
| | E ₁ | 1.75 | ±0.10 | 1.75 | ±0.10 | 1.75 | ±0.10 |
| | E ₂ min. | 14.25 | — | — | — | — | — |
| Tape thickness | T max. | 0.4 | — | 0.45 | — | 0.35 | — |
| Tape thickness with splice cover tape thickness | T ₁ max. | 0.1 | — | 0.1 | — | 0.1 | — |
| | K ₀ | 3.4 | ±0.15 | 7.0 | ±0.10 | 3.70 | ±0.10 |
| | Leader min. | 300 | — | 390 | — | 390 | — |
| | Trailer min. | 300 | — | 160 | — | 160 | — |

Reel dimensions

| | | | | | | | |
|-----------------------------------|---------------------|------|---------|------|---------|------|---------|
| Reel diameter | A max. | 340 | — | 340 | — | 340 | — |
| Core diameter | N min. | 50 | — | 50 | — | 50 | — |
| Space between flanges less device | W ₁ | 16.4 | -0/+2.0 | 16.4 | -0/+2.0 | 16.4 | -0/+2.0 |
| Reel width | W ₂ max. | 22.4 | — | 22.4 | — | 22.4 | — |

TS600

| Dimension Description | EIA Mark | Dimension (mm) | Tolerance |
|----------------------------|---------------------|----------------|-----------|
| Carrier tape width | W | 32 | ±0.3 |
| Sprocket hole pitch | P ₀ | 4.0 | ±0.1 |
| | P ₁ | 16 | ±0.1 |
| | P ₂ | 2.0 | ±0.1 |
| | A ₀ | 10 | ±0.1 |
| | B ₀ | 19.2 | ±0.1 |
| | B ₁ max. | 21.6 | — |
| Sprocket hole diameter | D ₀ | 1.5 | -0/+1.0 |
| | F | 14.2 | ±0.1 |
| | E ₁ | 1.75 | ±0.1 |
| | E ₂ min. | 28.4 | ±0.1 |
| | Tape thickness | T max. | 0.50 |
| Tape thickness with splice | T ₁ max. | 0.1 | — |
| | K ₀ | 13.2 | ±0.1 |
| | Leader min. | 390 | — |
| | Trailer min. | 160 | — |

Reel Dimensions

| | | | |
|-----------------------------------|---------------------|------|---------|
| Reel diameter | A max. | 360 | — |
| Core diameter | N min. | 50 | — |
| Space between flanges less device | W ₁ | 32.4 | -0/+2.0 |
| Reel width | W ₂ max. | 40 | — |

Table T9 TS Tape and Reel Specifications for Telecommunications and Networking Devices Cont'd

TS devices are packaged per EIA 481 and EIA 481-2 standards. See Figures T25 and T26 for details.

TSM600

| Dimension Description | EIA Mark | Dimension (mm) | Tolerance |
|----------------------------|---------------------|----------------|-----------|
| Carrier tape width | W | 32 | ±0.3 |
| Sprocket hole pitch | P ₀ | 4.0 | ±0.1 |
| | P ₁ | 24 | ±0.1 |
| | P ₂ | 2.0 | ±0.1 |
| | A ₀ | 11.2 | ±0.1 |
| | B ₀ | 17.8 | ±0.1 |
| | B ₁ max. | | 23.45 |
| Sprocket hole diameter | D | 1.5 | -0/+1.0 |
| | F | 14.2 | ±0.1 |
| | E ₁ | 1.74 | ±0.1 |
| | E ₂ max. | 28.4 | ±0.1 |
| Tape thickness | T max. | 0.5 | ±0.5 |
| Tape thickness with splice | T ₁ max. | 0.1 | |
| | K ₀ | 11.9 | ±0.1 |
| | Leader min. | 390 | |
| | Trailer min. | 160 | |

Reel Dimensions

| | | | |
|-----------------------------------|---------------------|------|---------|
| Reel diameter | A max. | 360 | |
| Core diameter | N min. | 50 | |
| Space between flanges less device | W ₁ | 32.4 | -0/+2.0 |
| Reel width | W ₂ max. | 40 | |

Figure T25 EIA Referenced Taped Component Dimensions for TS Devices

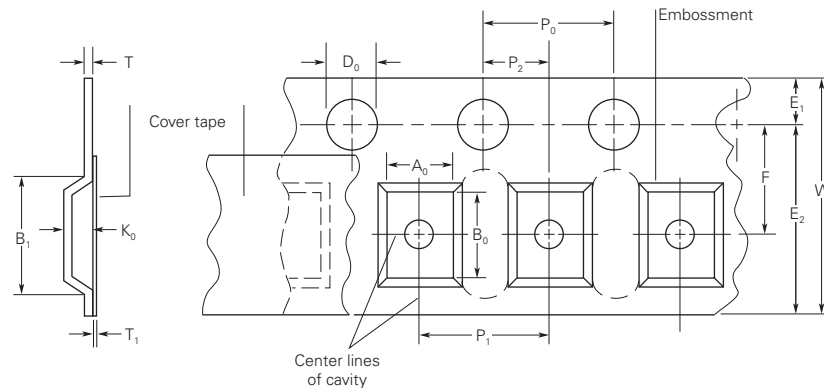
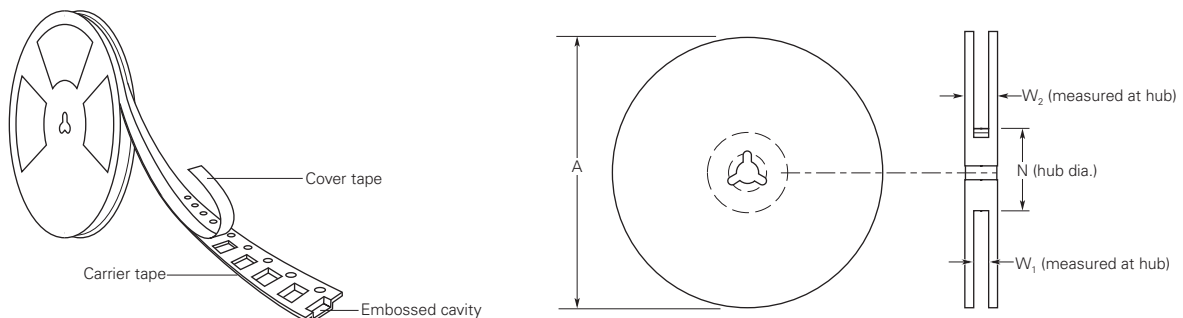


Figure T26 EIA Referenced Reel Dimensions for TS Devices



Resistance-sorted and Resistance-matched Devices

Most TCF, TRF and TS devices are available in resistance-sorted and/or resistance-matched versions.

Resistance-sorted Devices

Resistance-sorted devices (part number suffix “Rx”, where x = 1, 2, A, B, C, F etc.) are supplied with resistance values that are within specified segments of the device’s full range of resistance.

Feature

- Narrow resistance range.

Benefits

- Greater flexibility for design engineers.
- Lower resistance devices can allow for increased loop length on line card designs.
- Higher resistance devices may provide greater protection by offering faster time-to-trip.

Resistance-matched Devices

Resistance-matched devices are supplied such that all parts in one particular package (or reel) are within 0.5Ω of each other (1.0Ω for TRF250-080T devices). Individual matched packages are supplied from the full resistance range of the specified device.

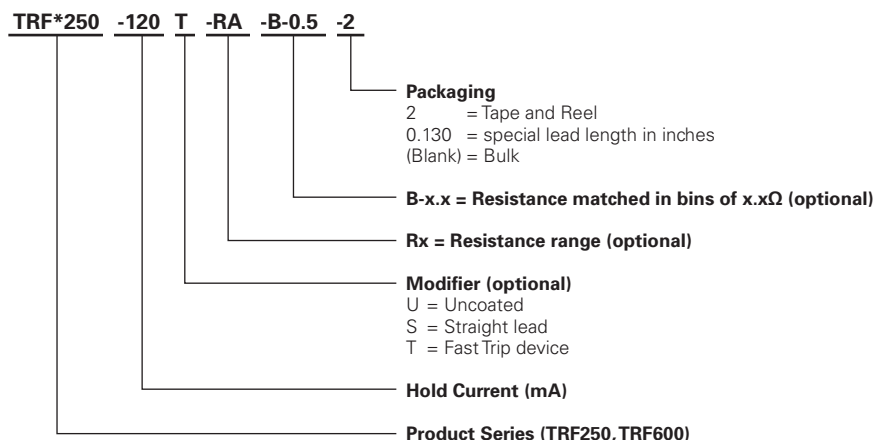
Feature

- Tighter resistance balance between any two parts in a package.

Benefits

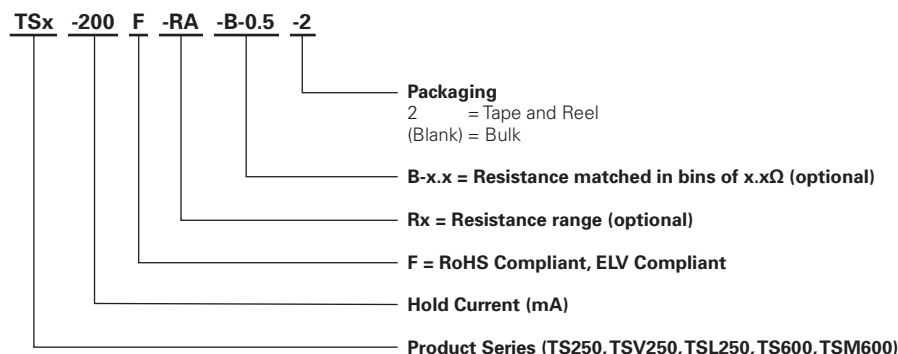
- Resistance-matched devices may reduce the tip-ring resistance differential, reducing the possibility of line imbalance.

Part Numbering System for Radial-leaded Telecommunications and Networking Devices

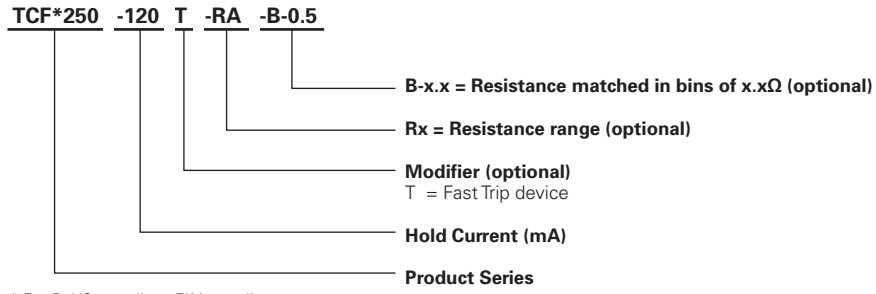


* F = RoHS compliant, ELV compliant

Part Numbering System for Surface-mount Telecommunications and Networking Devices



Part Numbering System for Chip Telecommunications and Networking Devices



* F = RoHS compliant, ELV compliant